Element 4 - Water Elevations (2010)

The 2010 water elevation monitoring program included operation and maintenance of 16 tide gauging stations near the barriers as shown in Figure 5-1. The 2010 monitoring program covers the period from January 2010 through December 2010, where stage is monitored at various stations with remote sensors.

Instrumentation recorded water surface elevation at 15-minute intervals. Later, the data records were retrieved and downloaded to a computer for subsequent analysis.

Data collected at these stations were used to determine effects of the barriers on the water surface elevations and circulation patterns in the South Delta. Circulation patterns are estimated using the water surface elevation data as an input to the hydrologic mathematical model (DSM2). Results of the model can be found in Chapter 7 of this report

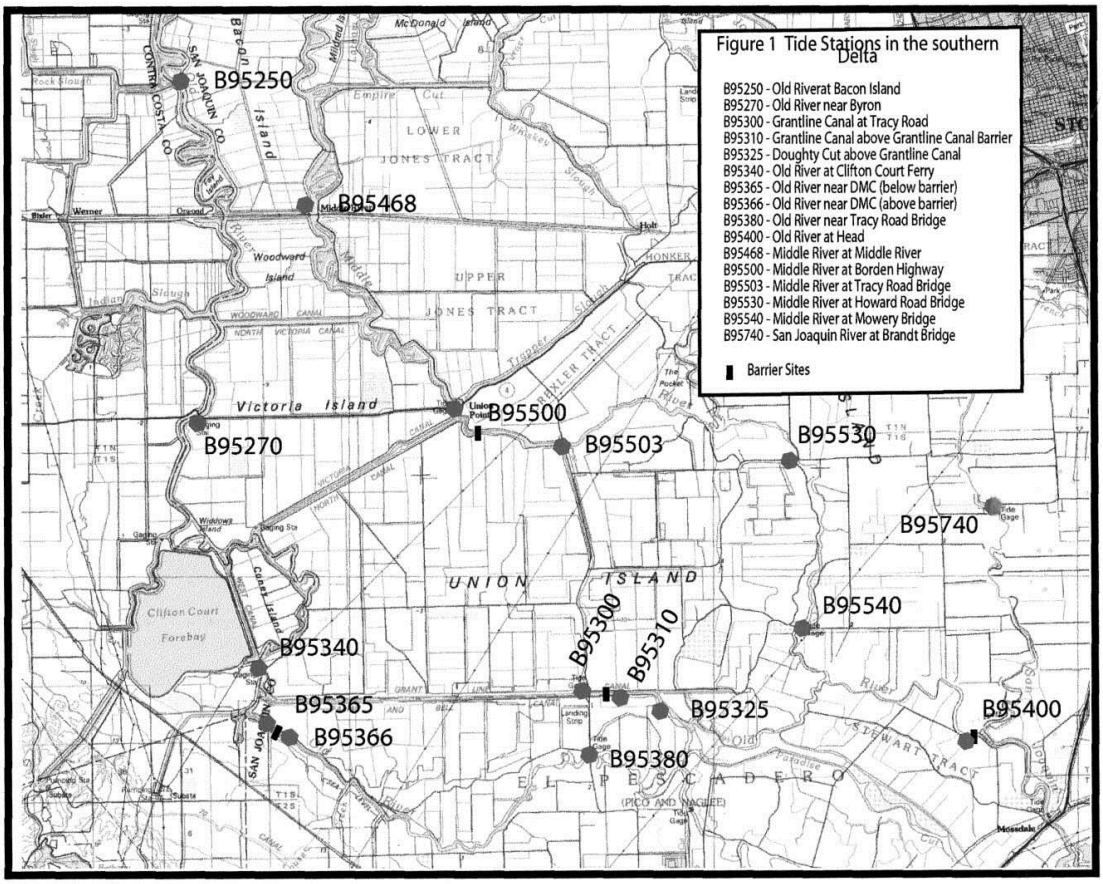

Figure 5-1. Tide Stations in the Southern Delta

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Tides along the Pacific Coast exhibit a cycle of 2 high and 2 low tides over an approximately 25-hour period (Figure 5-2). These cycles vary in height throughout the day. Two elements make up a typical tidal curve.

- The tidal range is the difference between the highest and lowest tidal elevations.
- The daily inequality is the difference between the heights of successive high or low tides and the time between corresponding high or low stands of sea level.

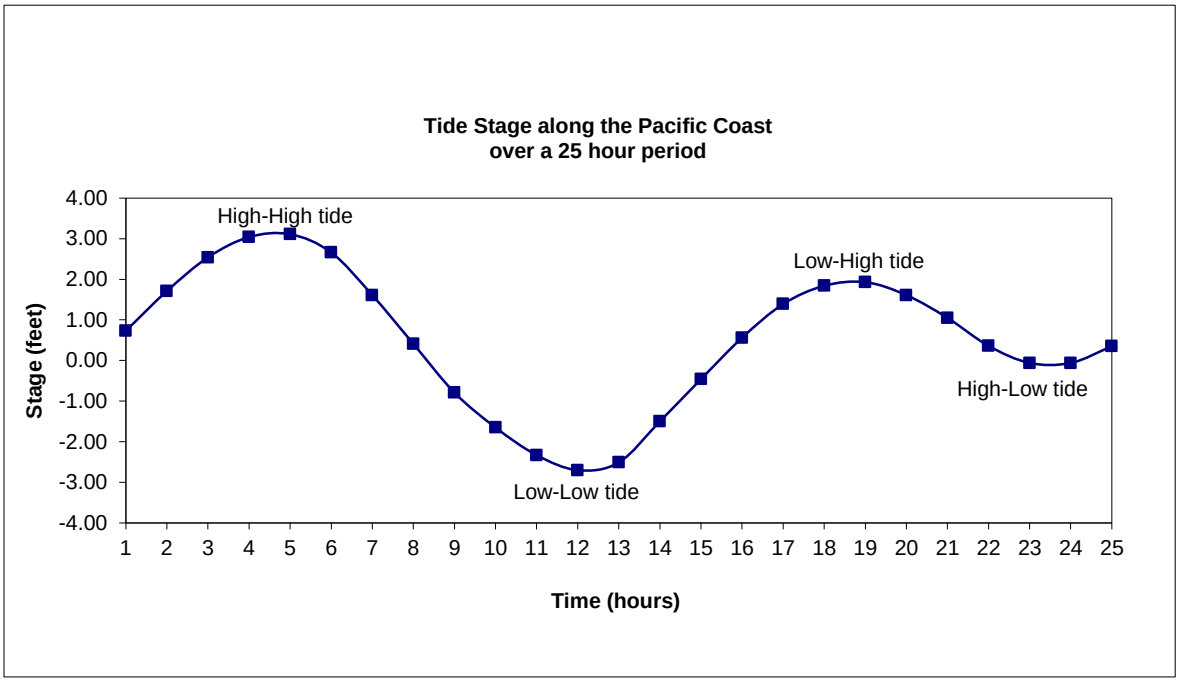


Figure 5-2. Tide Stage Variation over a 25-Hour Cycle

A biweekly pattern of spring and neap tides is overlaid on top of the daily pattern. Additional patterns occur at longer intervals throughout the year.

The primary objectives of the Temporary Barriers Program, specifically the agricultural barriers (Old River near Tracy (ORT), Middle River (MR), and Grant Line Canal (GLC)) is to improve water elevations for farmers during the irrigation season. This goal is achieved by installing barriers with culverts that restrict flow in the downstream direction resulting in increased water levels upstream of the barrier. During periods of increasing (flood) tides, the flap gates open and allow flow in the upstream direction. In addition, during high flood tides, water also flows over the barrier, thereby further increasing water level upstream of the barrier. When the tide ebbs the culvert flap-gates close and trap water upstream of the barrier. The flood tide recharges and maintains sufficient water stored above the barriers for agriculture diversion during the ebb tide, and through to the next flood tide. The agricultural barriers are constructed from rock with embedded culverts that equipped with flap-gates on the upstream inlets which allow flow in
the upstream direction. Design of the 3 agricultural barriers varies slightly due to differences in upstream channel geometry.

The following are highlights of barrier installation effects:

- At low tide, water surface elevation upstream of the barrier is raised, but the elevation downstream follows the tidal cycle.
- High tide water surface elevations upstream of the barrier are slightly delayed due to restrictions caused by the culverts and the time it takes for the flood tide to overtop the barriers' weir.
- During ebb tides, culvert flap gates close and trap water upstream of the barriers.

Middle River Barrier

The Middle River (MR) barrier abutments are constructed to an elevation of +3.0 feet National Geodetic Vertical Datum (NGVD) and have six 48-inch diameter culverts. The center weir is 140 feet wide and constructed to an elevation of +1.0 foot NGVD (Figure 5-3). The center portion of the barrier is removed seasonally, while the culverts and the abutments remain in place year-round. Three culverts are located in the north abutment, and 3 culverts are located in the south abutment.

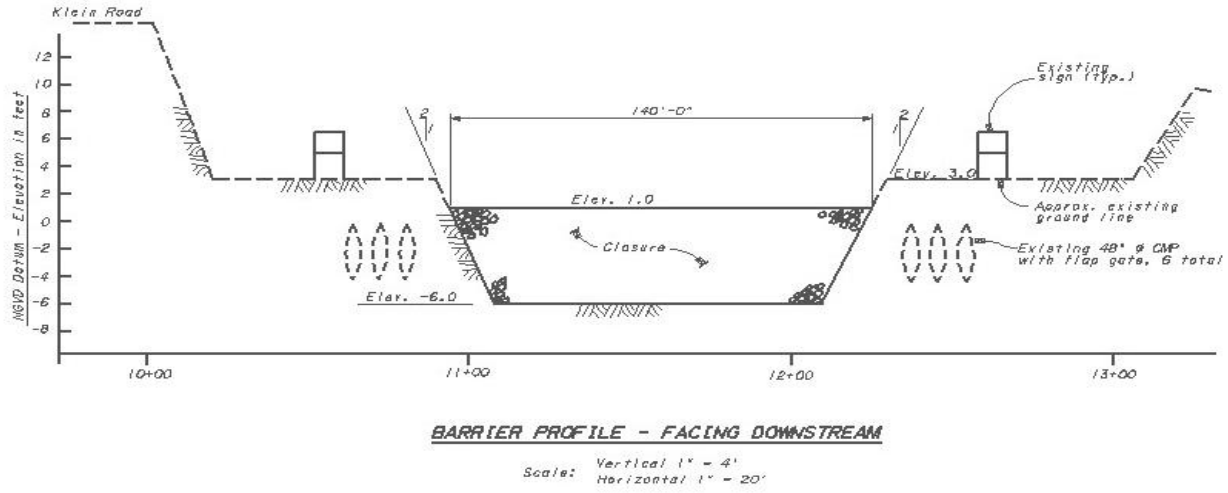
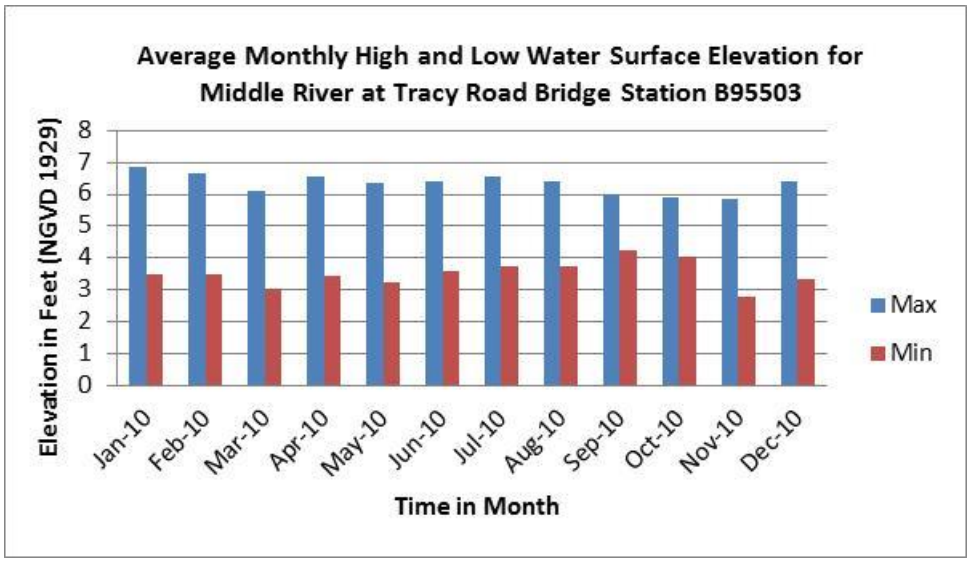


Figure 5-3. Middle River Barrier Profile

The installation of MR barrier started on May 19, 2010. The channel closure and construction completion were achieved on May 24, 2010, with culvert flap gates tied open. The flap gates were tidally operational from June 11, 2010, until the barrier breaching on October 28, 2010. The MR barrier was notched on September 15, 2010, to allow passage of adult salmon. For the 2010 operation, the MR agricultural barrier was allowed to remain until the end of October, 2010. The MR barrier removal work began on October 28, 2010, the weir was breached on October 28, 2010, and the barrier fully removed on November 02, 2010.

Water level monitoring was conducted at 2 nearby tide recording stations: at B95500 downstream of this barrier at Borden Highway (Highway 4) and at B95503 just upstream of the MR barrier at Tracy Road Bridge.

Figure 5-4 shows the mean monthly high tides and mean monthly low tides upstream and downstream of the Middle River barrier from January 2010 to December 2010. The barrier was in operation from late May through late October 2010. In May, Figure 5-4 showed a slight increase in mean monthly low water surface elevation between the downstream and the upstream sides of the barrier, a little over a half-foot increase from June through August and more than one foot increase of monthly low water level for September and October.



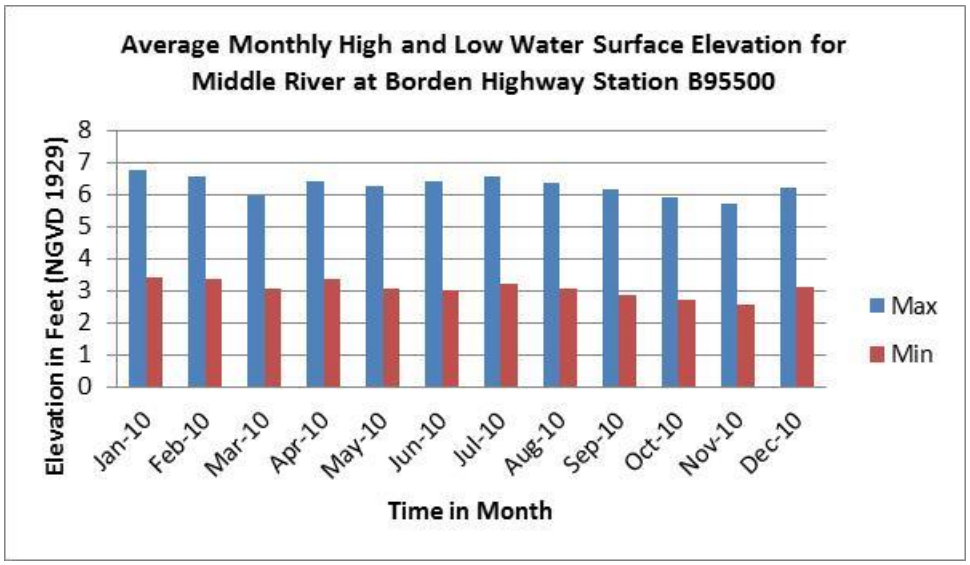


Figure 5-4. Water Levels Upstream and Downstream of Middle River Barrier

Old River at Tracy

The Old River at Tracy (ORT) barrier is constructed to an elevation of +4.0 feet NGVD and has nine 48-inch diameter culverts. The center weir section is 75 feet wide and constructed to an elevation of +2.0 feet NGVD (Figure 5-5). The entire barrier structure is removed seasonally.

The installation of the ORT barrier started on May 10, 2010. The weir section was closed on June 03, 2010, and all flap gates were tied open. Construction was completed on June 08, 2010. The ORT barrier culvert flap gates were untied on June 11, 2010, and the barrier became in full tidal operation. On July 26, 2010, five culverts were tied open while four culverts remained tidally operated. On July 30, 2010, all 9 culverts were returned to tidal operation. In August 6, 2010, four culverts were tied open and the remaining five stayed in tidal operation. On August 13, 2010, all 9 culverts were tidally operated. On August 20, 2010, five culverts were tied open and four were tidal; all 9 culverts operated tidally on August 26, 2010.

On October 1, 2010, four culverts were tied open while the remaining five remained in tidal operation up until October 8, 2010, when all culverts returned to tidal operation. The ORT barrier remained tidally operated until October 19, 2010, which was the starting date of the construction removal of the barrier. The ORT barrier was breached on October 20, 2010, and was fully removed by November 4, 2010.

Water level monitoring was conducted at 2 nearby tide stations: (1) B95365, downstream of the ORT barrier; and (2) B95366 upstream of the barrier. Figure 5-6 shows mean monthly high tides and mean monthly low tides upstream and downstream of the ORT barrier from January 2010 to December 2010. June shows a one foot increase in mean monthly low water levels between the upstream and the downstream sides of the barrier. In July and August an increase of approximately 1½ feet, and more than 2 feet increase in September. October shows approximately a one foot increase.

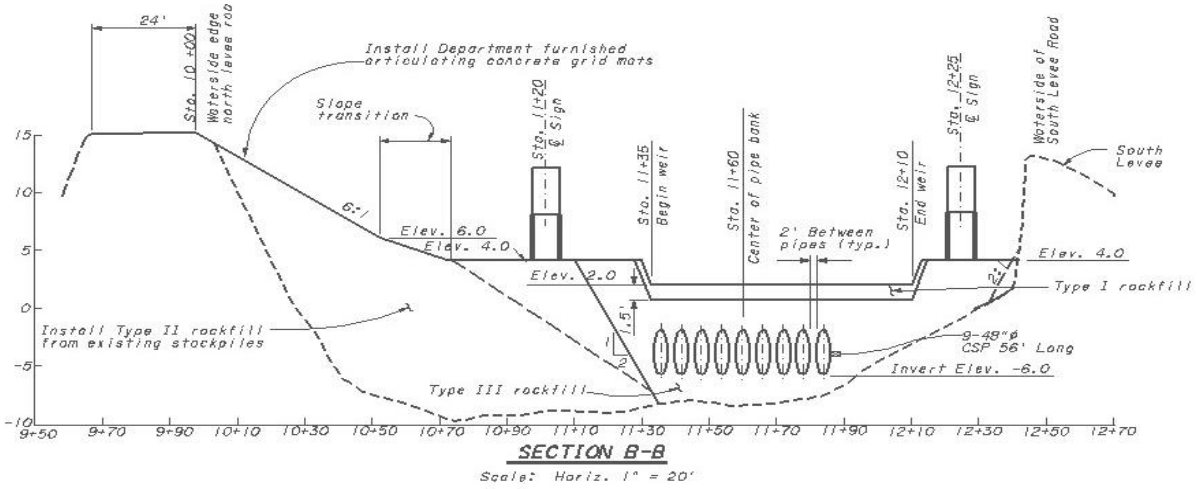
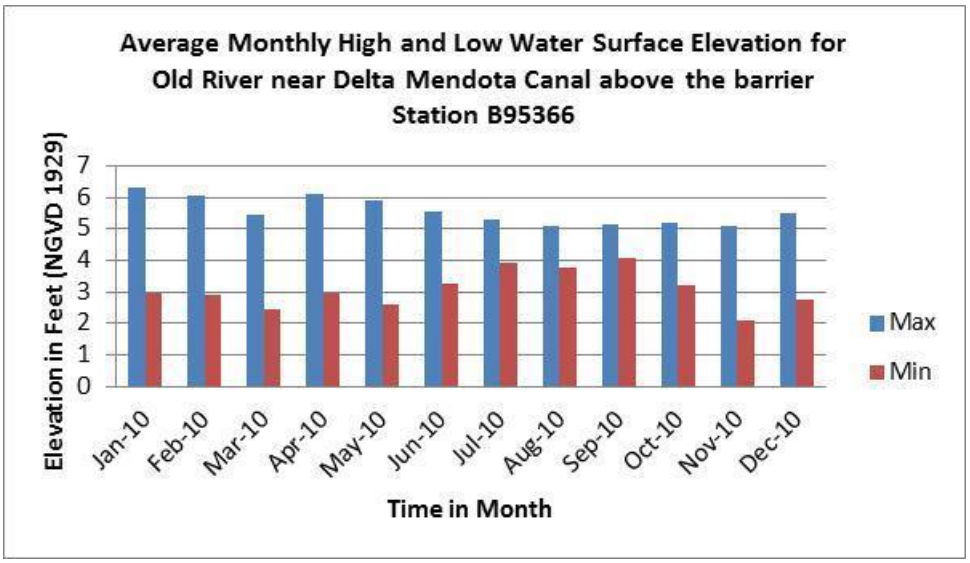


Figure 5-5. Old River at Tracy Barrier Profile



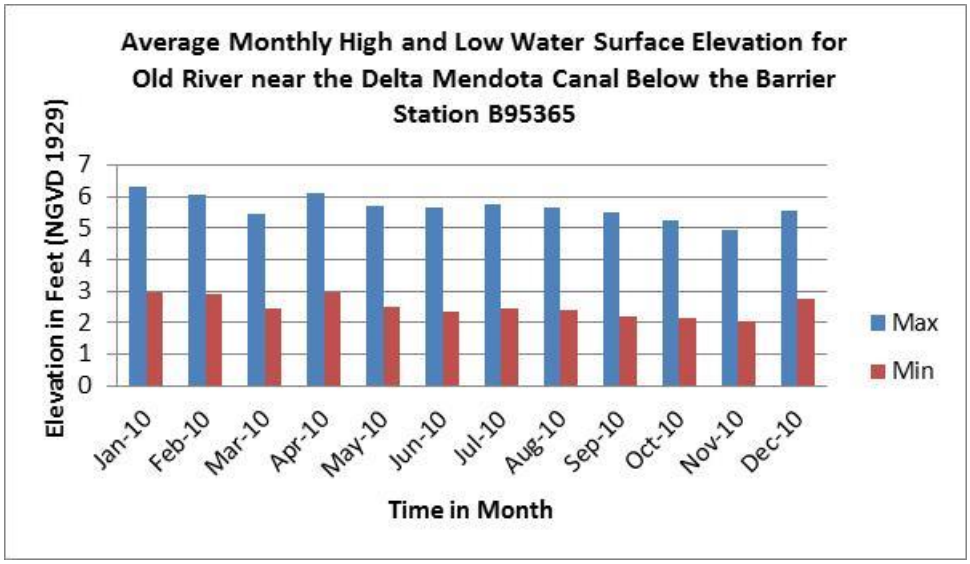


Figure 5-6. Water Levels Upstream and downstream of Old River at Tracy Barrier

Grant Line Canal Barrier

The Grant Line Canal (GLC) barrier is constructed to an elevation of +4.0 NGVD and has six 48-inch diameter culverts embedded in the southern abutment. The center weir section is 140 feet wide and constructed to an elevation of +1.0 foot NGVD. Figure 5-7 shows the culverts, fish flashboard structure, and the southern abutment of the GLC barrier, which remain in the channel year round. This will have less disruptive effects to the Swainsons-hawk habitat during the construction in spring.

In 2010, construction on the northern abutment of the rock barrier was started on June 16, 2010;and the weir section was closed on July 7, 2010; and construction completed by July 9, 2010. The flashboard structure was adjusted on September 15, 2010, to allow fish passage.

The barrier removal work began on October 11, 2010. The weir section was breached on October 14, 2010, and the barrier was fully removed by November 19, 2010. Water level monitoring was conducted at 2 nearby tide recording stations: (1) B95300 just downstream of the barrier, and (2) B95325 Doughty Cut upstream of the barrier.

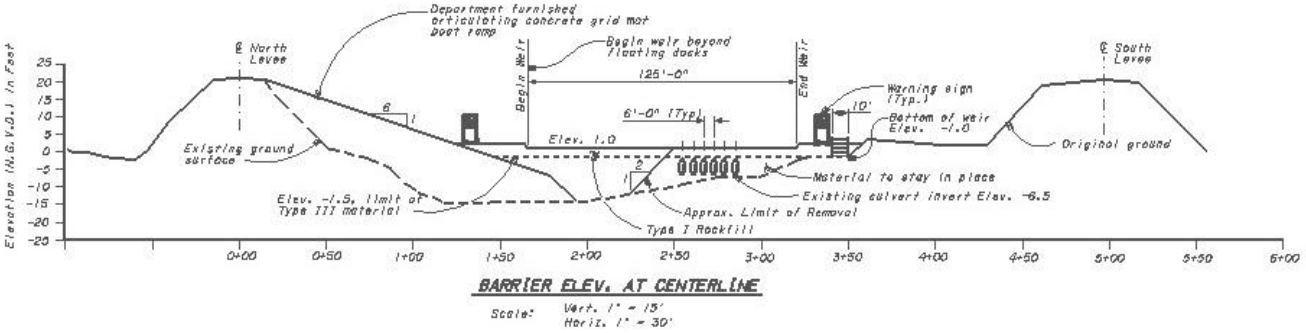
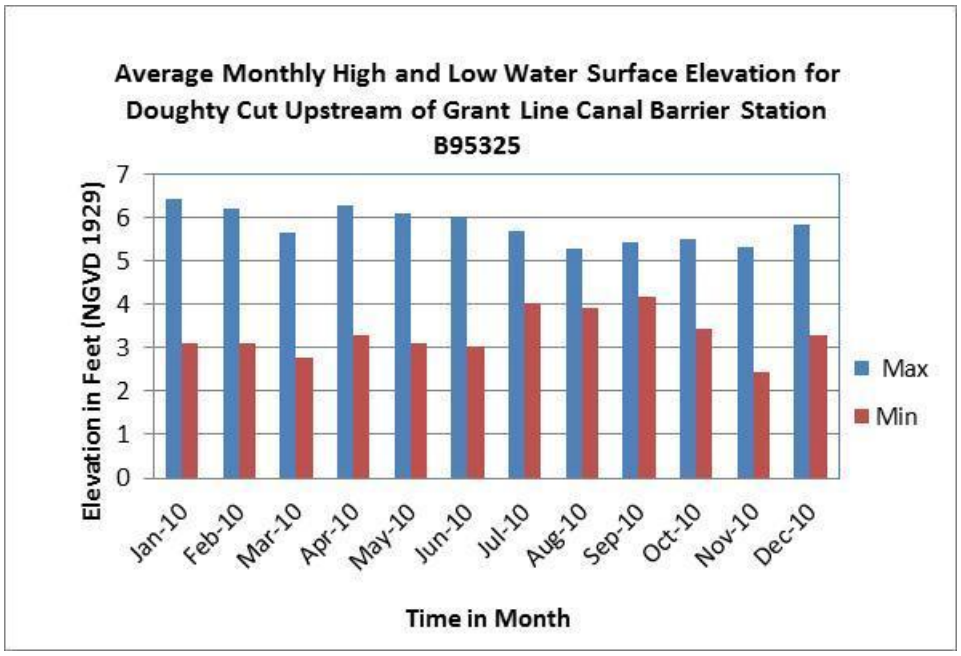


Figure 5-7. Grant Line Canal Barrier Profile

Figure 5-8 shows stages upstream and downstream of the GLC barrier from January 2010 to December 2010. Figure 5-8 compares the mean monthly low water levels on the upstream and the downstream ends of the GLC barrier. In June, there was approximately one-tenth of one foot increase at the station on the upstream side of the barrier in mean monthly low water surface elevation as compared against the station on the downstream side of the barrier. The mean monthly low water levels on the upstream end of the GLC barrier experienced an increase in July and in August of one foot. In addition, mean monthly low water levels on the upstream end of the GLC barrier experienced in September an increase of 1½ feet. In addition, water levels showed approximately a half-foot increase in mean low monthly water surface elevation during October.



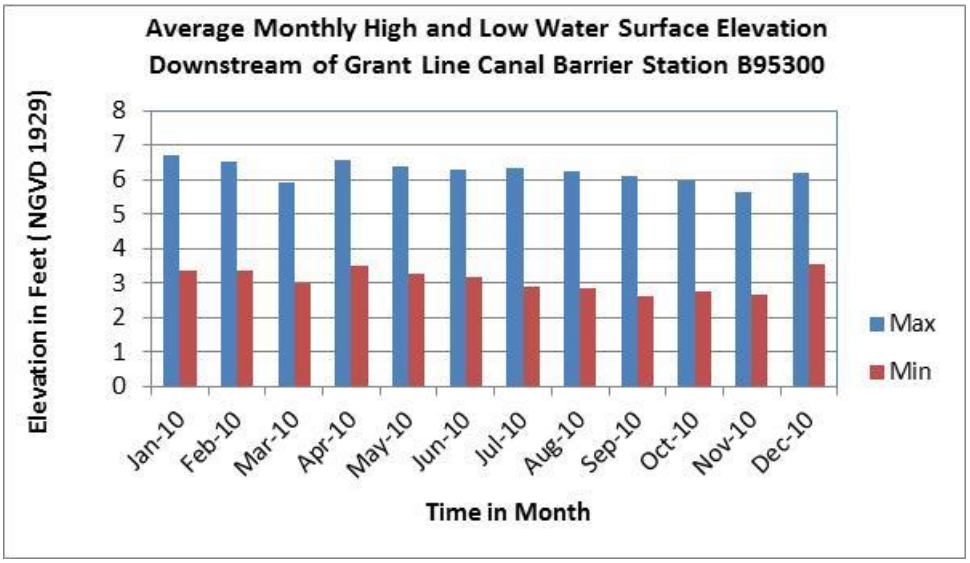


Figure 5-8. Water Levels Upstream and Downstream of Grant Line Canal Barrier

Old River at Head Barrier

The Head of Old River barrier (HORB) is designed as a fish barrier to prevent San Joaquin River Chinook Salmon Smolt from migrating down through Old River toward the Central Valley Project and State Water Project export facilities. Through the years, the design and installation of the HORB has been revised on several occasions to accommodate different needs. For the 2010 season, a non-physical barrier (NPB) was installed (Figure 5-9). The NPB used a combination of bubbles, lights, and sound to guide out-migrating Chinook salmon away from Old River to continue their migration down the San Joaquin River. The installation of the NPB began on April 5, 2010, and was completed by April 16, 2010. The April 27, 2010, fish release marked the beginning of the Vernalis Adaptive Management Program study to test the effectiveness of the NPB and the survivability of salmon smolts. May 19, 2010 marked the seventh and final fish release. The NPB dismantling began on June 16, 2010, and was completed by June 18, 2010.

In 2010, the fall HORB was not installed because existing flows and dissolved oxygen levels in the San Joaquin River were sufficient for the Chinook salmon.

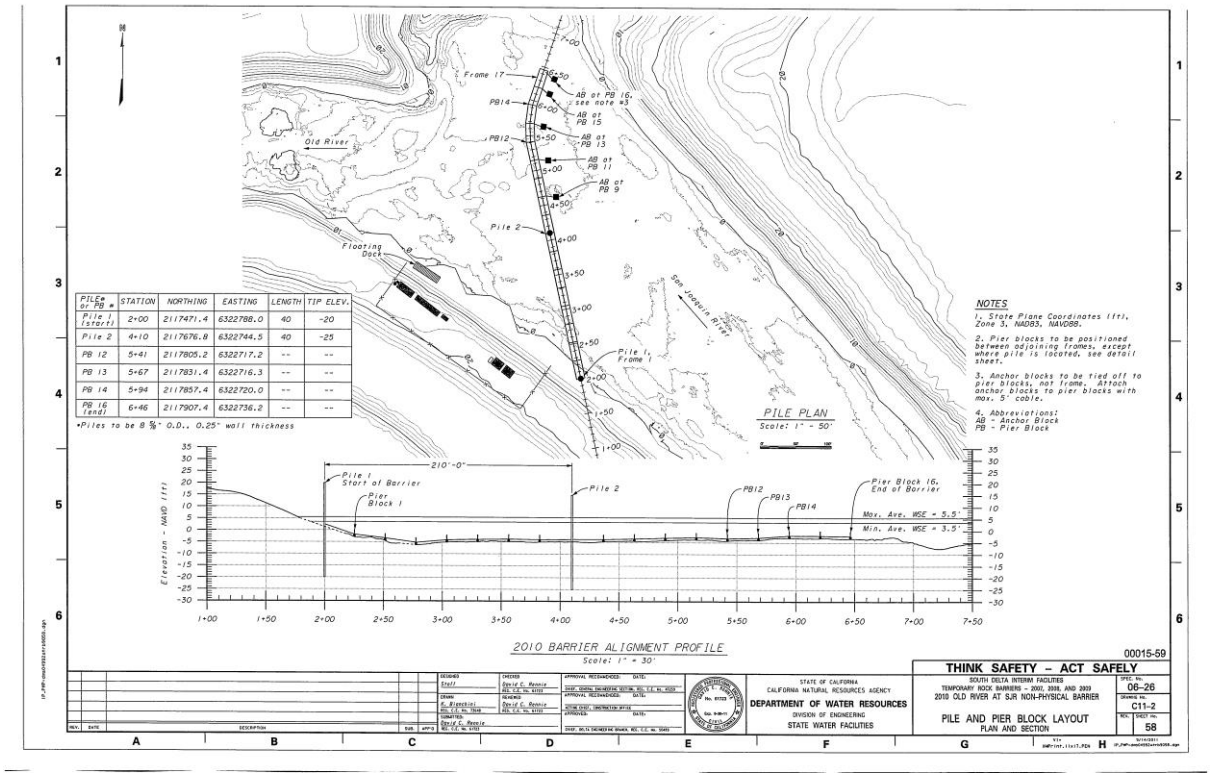


Figure 5-9. Spring Head of Old River Non-Physical Barrier

Figure 5-10 shows water levels in Old River at head approximately 1,000 feet below the NPB barrier location from January to December. In 2010, the mean monthly low water level was approximately 3½ feet NGVD during the month of November and the mean monthly high water level was slightly over 6 feet NGVD during the month of December.

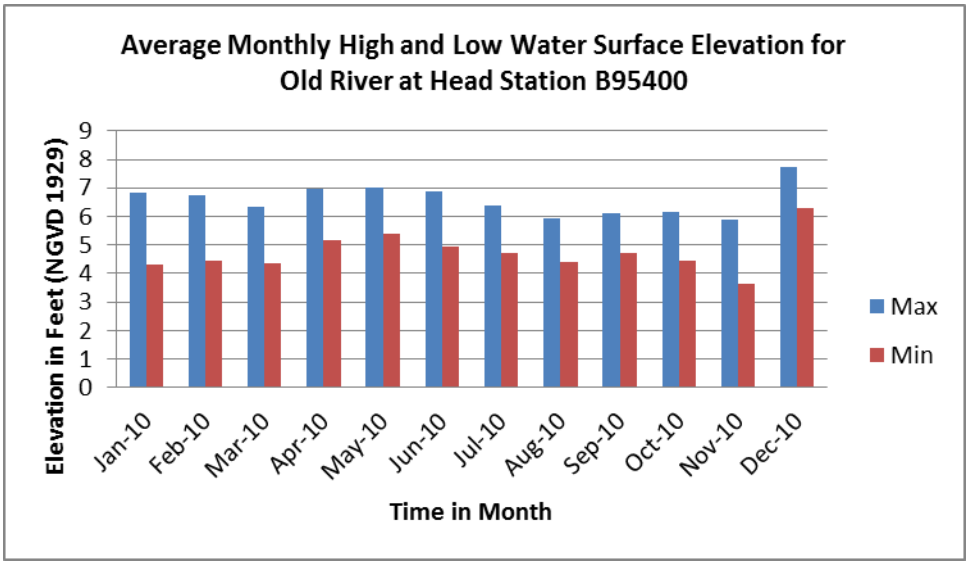


Figure 5-10. Water Levels Downstream of Head of Old River Barrier

Tom Paine Slough

Tom Paine Slough is a historic distributary of Old River and diverts water through 4 siphons and a box culvert into the slough from Old River. Figure 5-11 depicts the location of the 3 monitoring stations that report the water surface elevation in Tom Paine Slough: Tom Paine Slough above mouth (station number B95420), Tom Paine Slough above intake structure (station number B95421), and Tom Paine Slough at Pescadero Pump Plant 6 (station number B95425). Figure 5-12 shows water levels at Tom Paine Slough at all 3 monitoring locations.

Station B95420, Tom Paine Slough above mouth, reported a mean monthly low water level above 3 feet for the month of January, February, April, May, and June. In March 2010, the mean monthly low water was slightly less than 3 feet. For the months of August through September, the mean low monthly water level was at or above 4 feet NGVD. In October, the water level was approximately 3½ feet NGVD. In November and December, the mean low monthly water level was above 2 feet NGVD. Station B95420 data was missing during the period of June 13 through June 22, 2010, and from December 2 through December 31, 2010 due to instrument malfunction.

Station B95421, Tom Paine Slough above the intake structure, reported a mean monthly low level above 4 feet in January, February, and April. In March, May, and June the water level was above 3½ feet NGVD. From July through December, the mean low monthly water elevation was at or above 4 feet NGVD. Station B95421 data was missing during the period of October 6 through October 13, 2010 due to instrument malfunction.

Station B95425, Tom Paine Slough at Pescadero Pump Plant #6, showed a mean monthly low water level at or above 4 feet NGVD during the months of January through April; it also showed a mean

monthly low level of above 3 feet for the months of May through August. Water levels in September through December were above 4 feet NGVD.

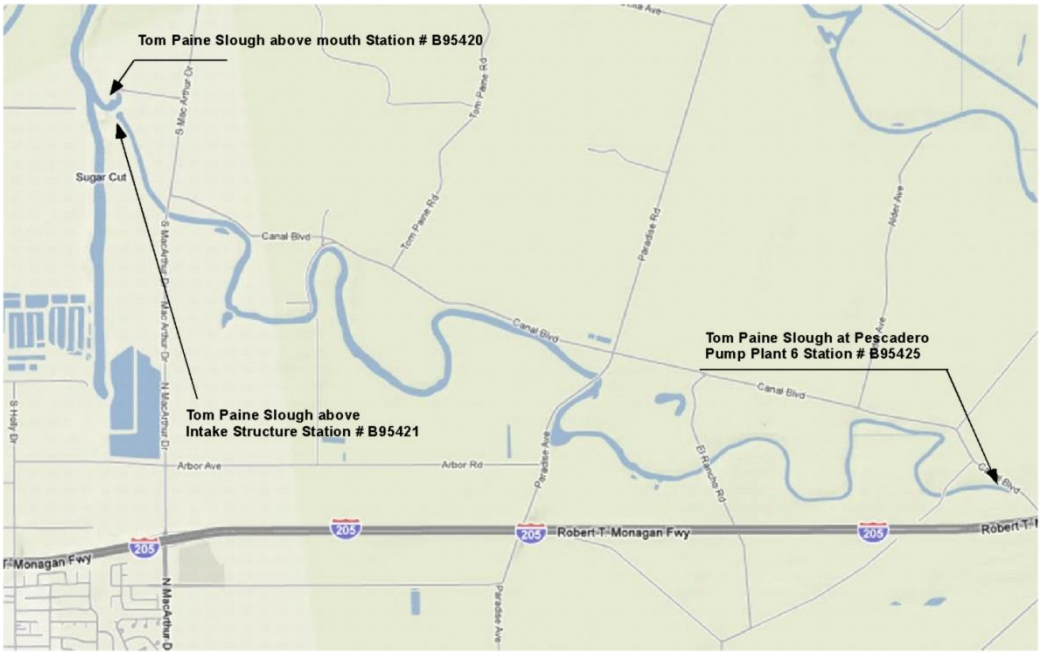
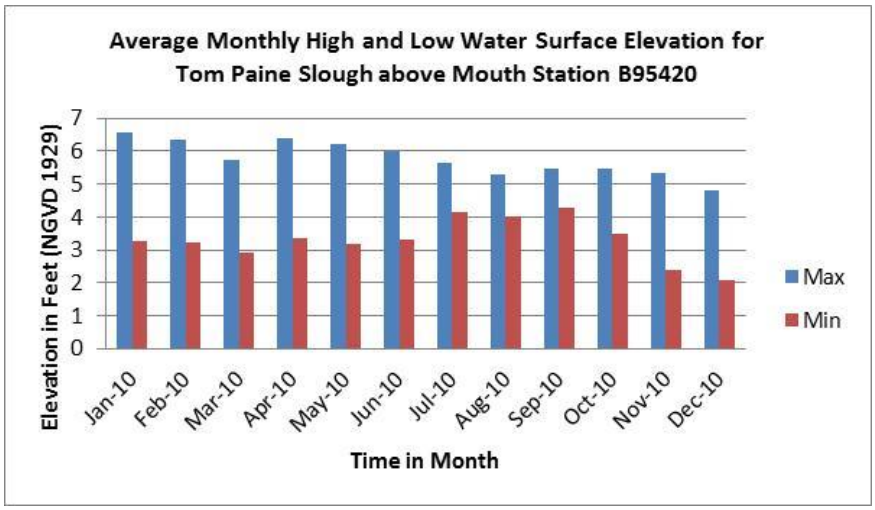
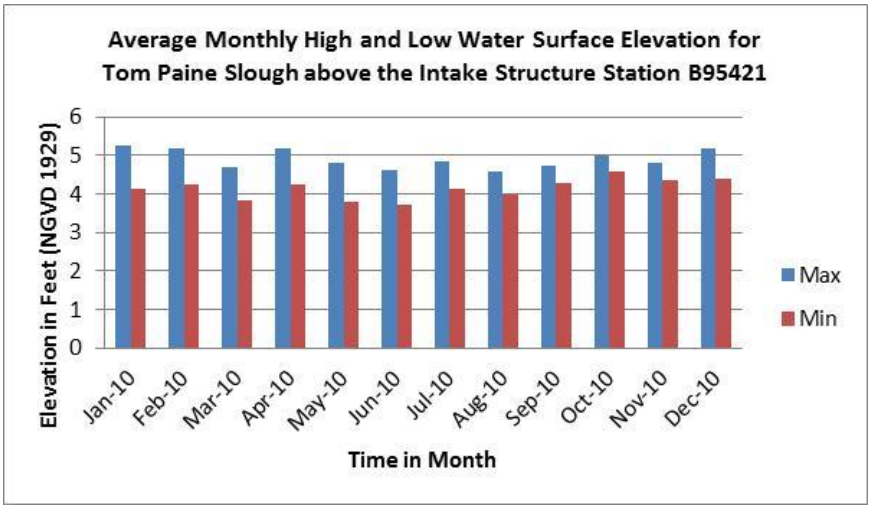


Figure 5-11. Location of water surface elevation stations at Tom Paine Slough





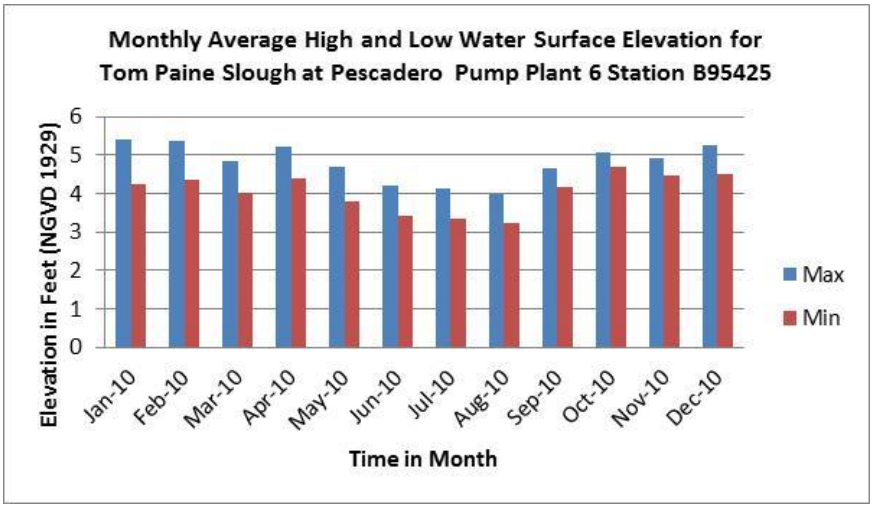


Figure 5-12. Water Levels at Tom Paine Slough above Mouth and above the Intake Structure and at Pump Plant #6